The following is a full explanation in determining NCEP data requirements.

The Eta model is run 4 times a day - the 00, 06, 12 and 18Z cycles. Each forecast is preceded by a 12h data assimilation (EDAS) period. Each EDAS period consists of four 3h segments. The four daily cycles and their EDAS periods are illustrated below (note that 00Z- and 12Z-cycle forecast will soon be extended to 60 hours).

```
          -12h EDAS--
  00Z cycle:  |--:--:--:--|--48h fcst-->
  06Z cycle:       |--:--:--:--|--48h fcst-->
  12Z cycle:            |--:--:--:--|--48h fcst-->
  18Z cycle:                 |--:--:--:--|--48h fcst-->

  Time scale: |    |    |    |    |    |
          12Z  18Z  00Z  06Z  12Z  18Z
```

In precipitation assimilation, during the 12-h data assimilation period (e.g. 00-12Z for the 12Z cycle), at each time step we compare the model-produced precip to the observed precipitation, then adjust the model's latent heating and moisture profiles to be consistent with the observed rainfall. So that means for each cycle of Eta/EDAS, we would like 12 hours' worth of hourly precipitation observations. When and where the observed precipitation is not available, we do not perform the adjustment at that time/location.

The above paragraph described the diabatic, or 'nudging' approach of precipitation assimilation. This is the approach that is closest to operational implementation. Currently there are some other approaches (3D and 4D variations) in the developmental stage at NCEP/EMC. They are beyond the scope of this discussion.

The decision in regards to the data request were based on the following concerns:
1) Ideally we would like to have all 12 hours of the EDAS period to be covered by the hourly precipitation observations, for the benefit of the subsequent model forecast

2) Model fields produced after 6h of EDAS is used as initial condition for the next cycle. For this reason, we would like the first half (the first 6 hours) of EDAS to be covered by the best hourly precipitation obs we can find, in order to produce a high quality analysis.

3) Since our two wishes, timeliness and data completeness work somewhat against each other, plus we have to consider the limitation on band-width, we figure it would be best if we receive the data in several batches each, rather than hourly, and allow some over-lapping of data between consecutive batches (when the lead time is long, we'd like the late, more complete analyses).

4) The model starting times are not cast in stone. As our computer systems and other demands on them changes, the starting time might be pushed back/forward somewhat. So we don't want to cut things too close, make a lot exacting demands on our RFC friends, only to have to change the cutoff times a few months down the road.

5) We'd like to keep our requests relatively simple.

The four Eta/EDAS cycles do not have uniform cut-off time:

```
   Run Cycle   Job Start
     00Z        2310Z
     06Z        0600Z
     12Z        1030Z
     18Z        1830Z
```

To assimilate the hourly precipitation analyses, for each of the 3h EDAS segments, before we start the model integration, we need to have the precipitation analyses for these 3 hours ready. Model integration for the first 3h EDAS segment does not start until 15-20 minutes after the job starts (job first does preparatory work, such as computing boundary conditions).

Based on the above job start times, I calculated the data cutoff time for each of the 4 daily Eta/EDAS cycles (note: in my 2 Mar email where only the calculation for the 12Z cycle was done, I got the 'lead time' for the 1st and 3rd EDAS segment wrong. Sorry. I've checked the following over several times and am convinced that everything is accurate, so far).

```
-----------------Timeline Requirement, for 00Z Eta/EDAS ----------------
precip
obs #   Precip accum period   Needs to be at NCEP     Lead time
  1         12-13Z          2325Z          10h25m |
  2         13-14Z          2325Z           9h25m |- 1st EDAS
  3         14-15Z          2325Z           8h25m |  segment

  4         15-16Z          2340Z           7h40m |
  5         16-17Z          2340Z           6h40m |- 2nd EDAS
  6         17-18Z          2340Z           5h40m |  segment

  7         18-19Z          2355Z           4h55m |
  8         19-20Z          2355Z           3h55m |- 3rd EDAS
  9         20-21Z          2355Z           2h55m |  segment

 10         21-22Z          0010Z           2h10m |
 11         22-23Z          0010Z           1h10m |- 4th EDAS
 12         23-00Z          0010Z            10m   |  segment
```

```
-----------------Timeline Requirement, for 06Z Eta/EDAS ----------------
precip
obs #   Precip accum period   Needs to be at NCEP     Lead time
  1         18-19Z          0615Z            11h15m |
  2         19-20Z          0615Z            10h15m |- 1st EDAS
  3         20-21Z          0615Z             9h15m |  segment

  4         21-22Z          0630Z             8h30m |
  5         22-23Z          0630Z             7h30m |- 2nd EDAS
  6         23-00Z          0630Z             6h30m |  segment

  7         00-01Z          0645Z             5h45m |
  8         01-02Z          0645Z             4h45m |- 3rd EDAS
  9         02-03Z          0645Z             3h45m |  segment

 10         03-04Z          0700Z             3h00m |
 11         04-05Z          0700Z             2h00m |- 4th EDAS
 12         05-06Z          0700Z             1h00m |  segment


-----------------Timeline Requirement, for 12Z Eta/EDAS ----------------
precip
obs #   Precip accum period   Needs to be at NCEP     Lead time
  1         00-01Z          1045Z             9h45m |
  2         01-02Z          1045Z             8h45m |- 1st EDAS
  3         02-03Z          1045Z             7h45m |  segment

  4         03-04Z          1100Z             7h00m |
  5         04-05Z          1100Z             6h00m |- 2nd EDAS
  6         05-06Z          1100Z             5h00m |  segment

  7         06-07Z          1115Z             4h15m |
  8         07-08Z          1115Z             3h15m |- 3rd EDAS
  9         08-09Z          1115Z             2h15m |  segment

 10         09-10Z          1130Z             1h30m |
 11         10-11Z          1130Z               30m |- 4th EDAS
 12         11-12Z          1130Z              -30m |  segment
```

```
-----------------Timeline Requirement, for 18Z Eta/EDAS ----------------
precip
obs #   Precip accum period   Needs to be at NCEP     Lead time
  1          06-07Z              1845Z                11h45m -|
  2          07-08Z              1845Z                10h45m  |- 1st EDAS
  3          08-09Z              1845Z                 9h45m _| segment

  4          09-10Z              1900Z                 9h00m -|
  5          10-11Z              1900Z                 8h00m  |- 2nd EDAS
  6          11-12Z              1900Z                 7h00m _| segment

  7          12-13Z              1915Z                 6h15m -|
  8          13-14Z              1915Z                 5h15m  |- 3rd EDAS
  9          14-15Z              1915Z                 4h15m _| segment

 10          15-16Z              1930Z                 3h30m -|
 11          16-17Z              1930Z                 2h30m  |- 4th EDAS
 12          17-18Z              1930Z                 1h30m _| segment
```

In other words, each hour's of precip accum obs would (ideally) be used twice by two consecutive EDAS cycles spaced 6h apart. For example, precip accum ending at 04Z would first be used by the 06Z cycle EDAS, then several hours later used by the 12Z cycle. For this particular hour's obs, the lead time required by the 06Z cycle is 3 hours while the lead time required by the 12Z cycle is 7 hours. So for the 12Z cycle, we would like to get a 'late' (more complete) version of the 04Z precip analysis. The chart below shows how and when each hour's precip obs would be used by two consecutive cycles of EDAS:

```
               needed by 2nd half    needed by 1st half
  Precip accum     of earlier EDAS       of the next EDAS

    00-01Z          0645Z |              1045Z |
    01-02Z          0645Z |              1045Z |
    02-03Z          0645Z |-06Z          1045Z |-12Z
    03-04Z          0700Z | cyc          1100Z | cyc
    04-05Z          0700Z |              1100Z |
    05-06Z          0700Z |              1100Z |

    06-07Z          1115Z |              1845Z |
    07-08Z          1115Z |              1845Z |
    08-09Z          1115Z |-12Z          1845Z |-18Z
    09-10Z          1130Z | cyc          1900Z | cyc
    10-11Z          1130Z |              1900Z |
    11-12Z          1130Z |              1900Z |
```

```
12-13Z        1915Z |             2325Z |
13-14Z        1915Z |             2325Z |
14-15Z        1915Z |-18Z         2325Z |-00Z
15-16Z        1930Z | cyc         2340Z | cyc
16-17Z        1930Z |             2340Z |
17-18Z        1930Z |             2340Z |

18-19Z        2355Z |            0615Z-|
19-20Z        2355Z |            0615Z |
20-21Z        2355Z |-00Z        0615Z |-06Z
21-22Z        0010Z | cyc        0630Z | cyc
22-23Z        0010Z |            0630Z |
23-00Z        0010Z |            0630Z |
```

So ideally we would like each hour's obs to be sent twice: the first time 'round, timeliness is an issue, we'd like the data to arrive early to meet our cut-off times. The second time, we'd like it to be as late as possible to include more late-arriving data.

Given the above data cutoff times, you can see that there is no way that requirements 1-5 can all be met (requirement #1 cannot possibly be met completely - for example, the 12Z data for the 12Z cycle). We tried several configurations in our minds (for example, sending data 8 times a day in order to meet both #1 and #2 optimally), but they all turn out to be way too complicated. We finally realized that if we make some concession on requirement #1 (giving up data coverage for the last 2-3 hours of EDAS; use our own quick Stage II analysis to fill the gap) we can then best meet requirements #2-5.

1. Have the 'first draft' of the Stage III ready no later than 1h25m after the top of each hour

2. Four times a day, send the previous 10/9 hours' worth of data to us:
(send hourly data ending at)
13--> 22Z: by 2325Z (for 00Z cycle EDAS)
19--> 04Z: by 0525Z (for 06Z cycle EDAS)
01--> 09Z: by 1025Z (for 12Z cycle EDAS)
07--> 16Z: by 1725Z (for 18Z cycle EDAS)